

CLAIMS

What is claimed is:

1. A microelectromechanical scanner, comprising:
 - a substrate;
 - an oscillatory body carried by the substrate and coupled to the substrate for periodic movement along a movement path by a set of primary arms;
 - an actuator coupled to the oscillatory body and configured to drive the oscillatory body along the movement path; and
 - a first auxiliary arm separate from the primary arms and interposed between the oscillatory body and the substrate, the auxiliary arm being configured to provide an auxiliary force that opposes the movement of the oscillatory body along the movement path.
2. The microelectromechanical scanner of claim 1 wherein the first auxiliary arm is coupled to the oscillatory body along a first edge, further including a second auxiliary arm coupled to the oscillatory body along a second edge different from the first edge.
3. The microelectromechanical scanner of claim 2 wherein the movement path defines a pivot axis about which the oscillatory body moves and wherein the first and second edges are symmetrically positioned on opposite sides of the pivot axis.
4. The micro-electro-mechanical scanner of claim 1 further comprising a reflective layer carried by the oscillatory body.
5. The microelectromechanical scanner of claim 1 further comprising a pair of primary arms that support the oscillatory body and define the movement path.

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6. The microelectromechanical scanner of claim 5 wherein the primary arms are torsional arms that flex torsionally about a respective pivot axis to define the movement path.

7. The microelectromechanical scanner of claim 1 further including a gimbal ring interposed between the oscillatory body and the substrate, the gimbal ring being configured to support the oscillatory body, the gimbal ring further being coupled to the substrate in a manner that permits pivoting of the gimbal ring about a first pivot axis, wherein the auxiliary arm is coupled between the oscillatory body and the gimbal ring.

8. The microelectromechanical scanner of claim 7 wherein the oscillatory body is coupled to the gimbal ring in a manner that permits pivoting of the oscillatory body relative to the gimbal ring about a second pivot axis substantially orthogonal to the first pivot axis.

9. The microelectromechanical scanner of claim 1 further including a gimbal ring interposed between the oscillatory body and the substrate, the gimbal ring being configured to support the oscillatory body, the gimbal ring further being coupled to the substrate in a manner that permits pivoting about a first pivot axis, wherein the first auxiliary arm is coupled between the substrate and the gimbal ring.

10. The microelectromechanical scanner of claim 7 wherein the oscillatory body is coupled to the gimbal ring in a manner that permits pivoting of the oscillatory body relative to the gimbal ring about a second pivot axis substantially orthogonal to the first pivot axis.

11. The microelectromechanical scanner of claim 1 wherein the primary arms are torsional arms that flex torsionally about a respective pivot axis to define the movement path, further including a piezoelectric sensor carried one or more of the torsional arms and the auxiliary arm.
12. The microelectromechanical scanner of claim 11 wherein the piezoelectric sensor is carried by one or more of the auxiliary arms.
13. The microelectromechanical scanner of claim 12 wherein wherein the first auxiliary arm is coupled to the oscillatory body along a first edge, further including a second auxiliary arm coupled to the oscillatory body along a second edge different from the first edge and wherein the piezoelectric sensor is integral to the one or more of the auxiliary arms.
14. The microelectromechanical scanner of claim 11 wherein the piezoelectric sensor is carried by the torsional arm.
15. The microelectromechanical scanner of claim 1 wherein the primary arms are torsional arms that flex torsionally about a respective pivot axis to define the movement path, and wherein the torsional arm and the auxiliary arms define a resonant frequency suitable for a scanned beam display.
16. The microelectromechanical scanner of claim 1 further including a second auxiliary coupled to the oscillatory body.
17. The microelectromechanical scanner of claim 16 wherein the primary arms are coupled on a first two sides of the oscillatory body and the auxiliary arm is coupled to a third side on the oscillatory body different from the first two sides.

18. A microelectromechanical resonant device, comprising:
a base;
a movable body coupled to the base for resonant motion relative to the base about a pivot axis; and
a flexible member extending from the movable body, the flexible member being configured to flex in response to movement of the movable body about the pivot axis, the flexible member being coupled to the movable body at a location offset from the pivot axis.
19. The microelectromechanical resonant device of claim 18 wherein the movable body and flexible member form an integral body.
20. The microelectromechanical resonant device of claim 18 wherein the base, flexible member, and movable body are all formed from a semiconductor material.
21. The microelectromechanical resonant device of claim 18 wherein the movable body includes a reflective coating oriented to reflect light incident on the movable body along a path radial to the pivot axis.
22. The microelectromechanical resonant device of claim 18 further including a pair of torsional arms coupled to the movable body.
23. The microelectromechanical resonant device of claim 22 wherein the torsional arms are coupled on opposite sides of the movable body and define the pivot axis.
24. The microelectromechanical resonant device of claim 16 wherein the movable body includes at least four edges, and wherein the torsional arms are coupled to the movable body at a first two of the edges and the movable arms are

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coupled to the movable body at a second two of the edges different from the first two edges.

25. An optical scanner comprising:

an oscillatory body;

a body support coupled to the oscillatory body and configured to permit the oscillatory body to move about a pivot axis; and

a flexible arm coupled to the oscillatory body at a location offset from the pivot axis, the flexible arm being configured to flex in response to movement of the oscillatory body about the pivot axis, wherein flexing of the flexible arm exerts a force on the movable body that opposes movement of the movable body about the pivot axis

26. The optical scanner of claim 25 further including a sensor carried by the flexible member and responsive to flexing of the flexible member to produce a sense signal indicative of an angular orientation, velocity or acceleration of the oscillatory body relative to the pivot axis.

27. The optical scanner of claim 25 wherein the oscillatory body and the flexible arm are integrally formed from a common material.

28. The optical scanner of claim 25 further including a pair of torsional arms coupled to the oscillatory body and configured to define the pivot axis.

29. The optical scanner of claim 28 wherein the torsional arms are coupled on a first two sides of the oscillatory body and the flexible member is coupled to the oscillatory body on a third side different from the first two sides.

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30. The optical scanner of claim 25 wherein the oscillatory body is coupled to a substrate and wherein the oscillatory body includes a first electrode and the substrate includes a second electrode, the first and second electrodes being positioned to produce a force on the oscillatory body having a component oriented to produce pivoting of the oscillatory body about the pivot axis.

31. A method of scanning with a MEMs device having a movable mirror that is configured to pivot about a pivot axis, comprising the steps of:

pivoting the movable mirror about the pivot axis;

bending a flexible arm along an axis substantially normal to the pivot axis in response to the pivoting of the movable mirror about the pivot axis;

detecting bending of the flexible arm; and

producing an electrical signal in response to the detected bending of the flexible arm, the electrical signal being indicative of pivotal movement of the movable mirror about the pivot axis.

32. The method of claim 31 further including:

directing a beam of light at the movable mirror when the mirror is pivoting;

and modulating the beam of light in response to the produced electrical signal.

33. The method of claim 31 wherein detecting bending of the flexible arm includes monitoring electrical properties of the flexible arm.